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Researchers using new technology to study breath for toxins

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Breathing. Anyone reading this article is doing it right now. But what chemicals are we breathing in, and out? A group of Virginia Tech College of Engineering researchers has published a paper in the journal *Environmental Science & Technology* that details how to learn just that, using microelectromechanical systems to focus on toxins and everyday impurities that enter the body through the air we intake.

The research paper, "The Possibilities Will Take Your Breath Away: Breath Analysis for Assessing Environmental Exposure," was written by Andrea Dietrich, professor with the Charles E. Via Jr. Department of Civil and Environmental Engineering, and Masoud Agah, associate professor in the Bradley Department of Electrical and Computer Engineering, with two graduate students, Heather Vereb, an environmental sciences and engineering graduate student originally from Pittsburgh, and Bassam Alfeeli, a graduate of the electrical and computer engineering department and native of Kuwait City, Kuwait, now an associate research scientist at Kuwait Institute for Scientific Research.

"Breathing reflects both what we inhale and what we metabolize," said Dietrich, who also has studied contamination of iron and other metals in drinking water and its effect on users, and the phantom metallic tastes experienced by cancer patients undergoing chemotherapy and radiation therapy. "Toxins and non-toxins diffuse into the blood and then out of the body through breath."

The study of breath, including using odors of the mouth to determine an illness, is centuries old, and studies of exposure to benzene and other toxins via air have been ongoing since the 1970s. It also has been known for years that the body puts off naturally produced chemicals and odors when excited or fearful, hence the old and quite literal saying, "The smell of fear," said Dietrich.

But new technologies – including hair-thin sorption devices found in microelectromechanical systems – can detect trace amounts of possible toxins in a person's breath on the parts per billion or the micro-particle scale, and have improved test performance in terms of identifying biomarkers, and reduced analysis time, sample volume, and consumables such as solvents and reagents.

These improved tools of the lab come in conjunction with new discoveries in gaseous toxins found in significant quantities in our homes, workplaces, and outdoor surroundings, such as emissions from paints, carpeting, plastic-based flooring, according to the published paper. "The sources of some chemicals are well-known and extensively studied in the literature, while others simply appear in the complex chemical soup that surrounds us with no identified, or several potential, sources. Because they are present in a gaseous form, exposure is obligatory, as no one can refuse to breathe," the researchers wrote.

"The breath presents a composite of all doses, providing information about exogenous compounds absorbed from the surroundings, as well as changes in endogenous compounds which may result from such exposures. Achieving such goals will allow for the advancement of breath analysis as a means of quantifying environmental exposures and doses, as well as useful data which can eventually be used to limit individuals' exposure to harmful contaminant," the researches continued.

Dietrich and her collaborators ask subjects to breathe into sterile plastic, then process the captured exhaled air through small sorption devices about the size of a penny. There are several challenges to analyzing breath, including the presence of water vapor that can gunk up sensors, and the fact that no one yet knows what constitutes "normal" breath. "We don't really know what normal breath is – and there are likely variations in the number of compounds and concentrations depending on the individual and their activities," Dietrich said.

For instance: A person living in, say, Philadelphia – a large city with pollutants from buses, factories, and old buildings – breathes air containing different compounds than a person living in the rural mountains of Southwest Virginia. That said, scientists know what volatile compounds associated with pollution don't belong in the human body–. The study underway by Dietrich is looking at gaseous compounds, versus particles such as dust or sand, or the debris found at New York's Ground Zero immediately following the attacks against and collapse of the World Trade Center towers in 2001.

Dietrich and her colleagues hope to monitor the exhaled breath of their patients to identify and qualify the risk associated with exposure to environmental contaminants. "Achieving such goals will allow for the advancement of breath analysis as a means of quantifying environmental exposures and doses, measure biomarkers that are indicators of diseases, as well as provide useful data which can eventually be used to limit individuals' exposure to harmful contaminants. We will be waiting with bated breath," Dietrich and her colleagues conclude.

Provided by Virginia Tech

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